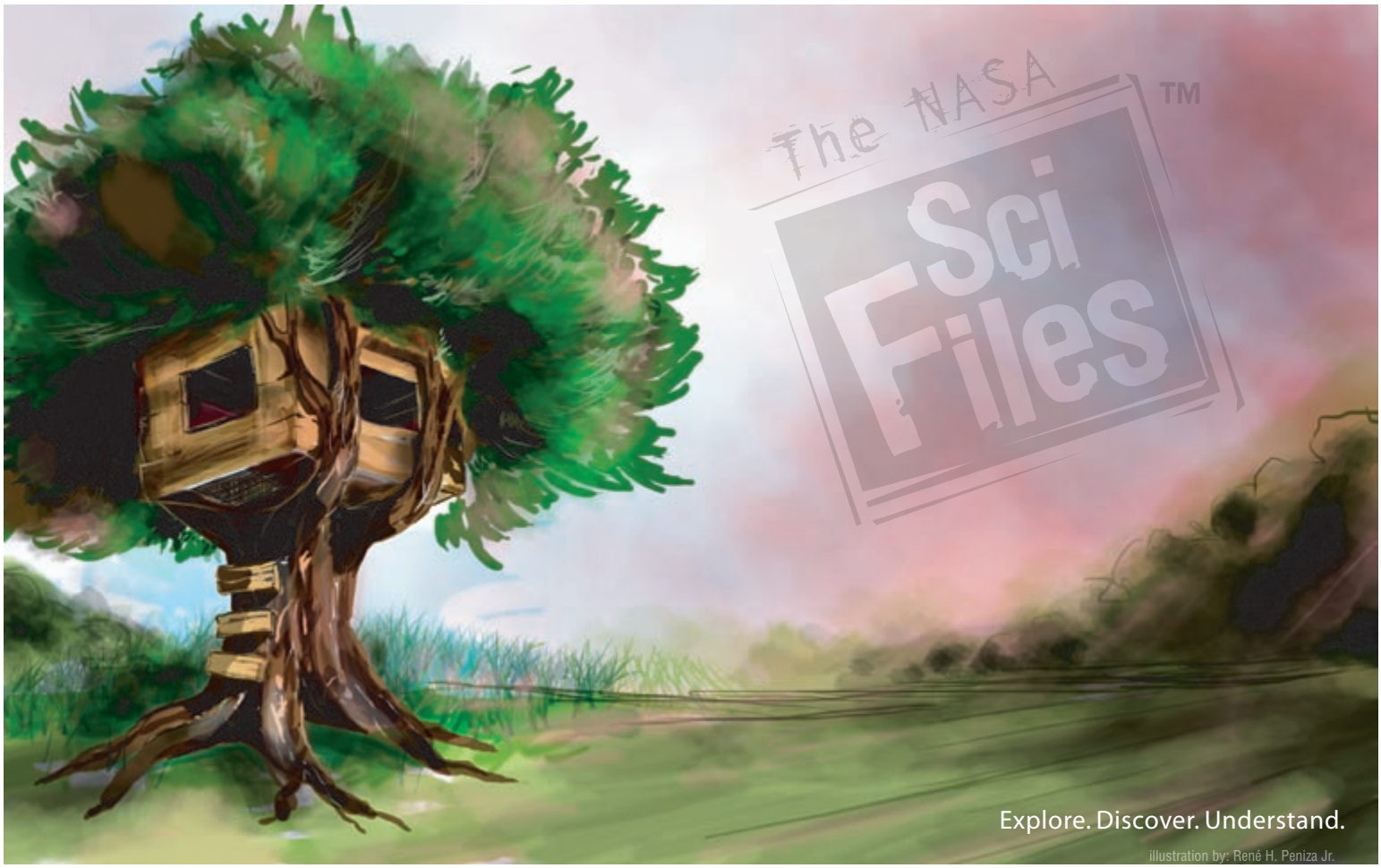
National Aeronautics and Space Administration
Langley Research Center
Hampton, VA 23681-2199

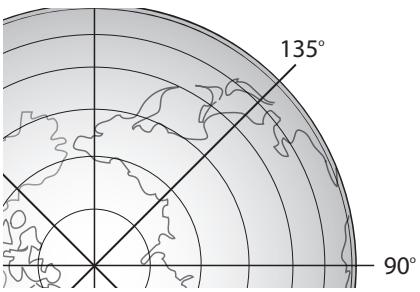
Educational Product	
Educators	Grades 3–5

EG-2005-05-04-LARC

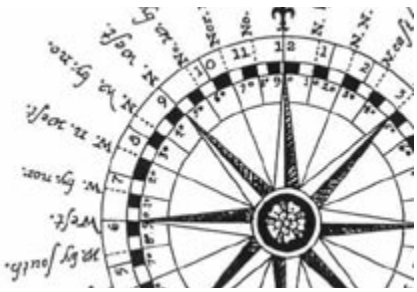
The Case of the Technical Knockout

An Educator Guide with Activities in Mathematics, Science, and Technology





student activities begin on page 19



The Case of the Technical Knockout educator guide is available in electronic format.
A PDF version of the educator guide for NASA SCI Files™ can be found at the NASA SCI Files™ web site:
http://scifiles.larc.nasa.gov

www.swe.org

www.sbo.hampton.k12.va.us

www.buschgardens.com

www.cnu.edu

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The NASA SCI Files™

The Case of the Technical Knockout

An Educator Guide with Activities in Mathematics, Science, and Technology

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For additional information about the NASA SCI Files™, contact Shannon Ricles at (757) 864-5044 or **s.s.ricles@larc.nasa.gov**.

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Registered users of the NASA SCI Files™ may request a Society of Women Engineers (SWE) classroom mentor. For more information or to request a mentor, e-mail **kimlien.vu@swe.org** or visit the NASA SCI Files™ web site **http://scifiles.larc.nasa.gov**

The NASA
Sci
Files
TM

Program Overview

Armed with Global Positioning System (GPS) receivers, compasses, maps, and travel bugs, the tree house detectives set off to do some "geocaching" in the national parks of Virginia. Unexpectedly, while trying to find their first cache, their GPS devices begin to give multiple coordinates, and the detectives think they might be lost. When they try to radio home base, they find that their two-way radios are also on the blink. Then, as quickly as the strange phenomenon began, it ends, and the detectives are back on track. They are concerned, however, that if the GPS and radio malfunctions occur again, they might not be so lucky. The detectives decide that they must solve this mystery and discover what caused their radio and GPS glitches. Their first stop is NASA Langley Research Center to speak with Charles Cope, a NASA pilot, to learn more about how a GPS is used for navigation. The next stop is a videoconference with Dr. D, who just happens to be in Oslo, Norway at the Viking Ship Museum. Dr. D tells the detectives how explorers have navigated around the world for thousands of years by using the stars, lodestones, and Iceland spar. Finally, they decide to prepare for their next expedition and head to the store to find a container for their cache.

Meanwhile, Tony and Catherine visit NASA Langley Research Center to talk to Mr. George Ganoe to learn more about a GPS and how it works. After speaking with Mr. Ganoe, the detectives decide that it probably wasn't the GPS satellite system that caused their problems. They begin to think that it might have something to do with radio waves, so they ask two of the NASA SCI Files™ Kids' Club members, Ole and Nina, to talk with Dr. D, who meets Ole and Nina at the ALOMAR Observatory in Andenes, Norway, where he explains the electromagnetic spectrum. Back in the U.S., Tony heads to Colorado and on the way stops by the University of Colorado to visit Dr. Fran Bagenal to learn more about electricity.

Still undecided about what might have caused the GPS and radio glitches, the detectives contact Ole and Nina to meet Dr. D again to learn about magnetism. Dr. D meets them at the Northern Lights Museum, where he performs several demonstrations and discusses how the Earth's magnetic field interacts with light particles coming from the Sun. To learn more about electromagnets, the tree house detectives dial up Mr. Jacobsen's class at Andenes Ungdomskole (middle school) in Andenes, Norway. Last stop for the detectives is NASA Goddard Space Flight Center in Greenbelt, Maryland, where RJ and Catherine talk with Dr. Nicky Fox to learn more about our star, the Sun.

Trying to put the final pieces of the puzzle together, the tree house detectives dial up Dr. Sten Odenwald to learn about solar flares, coronal mass ejections, and how they affect our Earth. To confirm their hypothesis, the detectives send Tony to visit Joe Kunches at the National Oceanic and Atmospheric Administration (NOAA) to learn more about space weather. At last the detectives think they know why their GPS receivers and radios went on the blink and had a few glitches. To wrap up the problem, they head to the airport to meet Dr. D as he returns from Norway.

National Science Standards (Grades K-4)

STANDARD	SEGMENT			
Unifying Concepts and Processes	**1**	**2**	**3**	**4**
Systems, orders, and organization	•	•	•	•
Evidence, models, and explanations	•	•	•	•
Change, constancy, and measurement	•	•	•	•
Evolution and equilibrium	•	•	•	•
Form and function	•	•	•	•
Science and Inquiry (A)				
Abilities necessary to do scientific inquiry	•	•	•	•
Understandings about scientific inquiry	•	•	•	•
Physical Science (B)				
Properties of objects and materials	•	•	•	•
Position and motion of objects	•	•	•	•
Light, heat, electricity, and magnetism	•	•	•	•
Earth and Space Science (D)				
Properties of earth materials	•	•	•	•
Objects in the sky	•	•	•	•
Changes in earth and sky	•	•	•	•
Science and Technology (E)				
Abilities of technological design	•	•	•	•
Understandings about science and technology	•	•	•	•
Abilities to distinguish between natural objects and objects made by humans	•	•	•	•
Science in Personal and Social Perspective (F)				
Changes in environments	•	•	•	•
Science and technology in local challenges	•	•	•	•
History and Nature of Science (G)				
Science as a human endeavor	•	•	•	•

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National Science Standards (Grades 5-8)

STANDARD	SEGMENT			
Unifying Concepts and Processes	**1**	**2**	**3**	**4**
Unifying Concepts and Processes	•	•	•	•
Systems, order, and organization	•	•	•	•
Evidence, models, and explanations	•	•	•	•
Change, constancy, and measurement	•	•	•	•
Form and function	•	•	•	•
Science as Inquiry (A)				
Abilities necessary to do scientific inquiry	•	•	•	•
Understandings about scientific inquiry	•	•	•	•
Physical Science (B)				
Properties and changes of properties in matter	•	•	•	•
Motion and forces	•	•	•	•
Transfer of energy	•	•	•	•
Earth and Space Science (D)				
Structure of the earth system	•	•	•	•
Earth in the solar system	•	•	•	•
Science and Technology (E)				
Abilities of technological design	•	•	•	•
Understanding about science and technology	•	•	•	•
Science in Personal and Social Perspectives (F)				
Science and technology in society	•	•	•	•
History and Nature of Science (G)				
Science as a human endeavor	•	•	•	•
Nature of science	•	•	•	•
History of science	•	•	•	•

National Mathematics Standards for Grades 3-5

STANDARD	SEGMENT			
Number and Operations	**1**	**2**	**3**	**4**
Understand numbers, ways of representing numbers, relationships among numbers, and number systems.			•	
Understand meanings of operations and how they relate to one another.			•	
Compute fluently and make reasonable estimates.			•	
Geometry				
Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.		•		
Specify location and describe spatial relationships using coordinate geometry and other representational systems.	•	•		
Use visualization, spatial reasoning, and geometric modeling to solve problems.		•		
Measurement				
Understand measurable attributes of objects and the units, systems, and processes of measurement.	•	•	•	•
Apply appropriate techniques, tools, and formulas to determine measurements.	•	•	•	•
Data Analysis and Probability				
Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.	•	•	•	•
Select and use appropriate statistical methods to analyze data.	•	•	•	•
Develop and evaluate inferences and predictions that are based on data.	•	•	•	•
Understand and apply basic concepts of probability.	•	•	•	•
Problem Solving				
Build new mathematical knowledge through problem solving.	•	•	•	•
Solve problems that arise in mathematics and in other contexts.	•	•	•	•
Apply and adapt a variety of appropriate strategies to solve problems.	•	•	•	•
Monitor and reflect on the process of mathematical problem solving.	•	•	•	•

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National Mathematics Standards for Grades 3-5

STANDARD	SEGMENT			
Communication	**1**	**2**	**3**	**4**
Organize and consolidate mathematical thinking through communication.			•	
Communicate mathematical thinking coherently and clearly to peers, teachers, and others.			•	
Representation				
Create and use representations to organize, record, and communicate mathematical ideas.			•	
Select, apply, and translate among mathematical representations to solve problems.			•	
Use representations to model and interpret physical, social, and mathematical phenomena.			•	

National Educational Technology Standards Performance Indicators for Technology-Literate Students Grades 3-5

STANDARD	SEGMENT			
Basic Operations and Concepts	**1**	**2**	**3**	**4**
Use keyboards and other common input and output devices efficiently and effectively.	•	•	•	•
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	•	•	•	•
Social, Ethical, and Human Issues				
Discuss common uses of technology in daily life and the advantages and disadvantages those uses provide.	•	•	•	•
Discuss basic issues related to responsible use of technology and information and describe personal consequences of inappropriate use.	•	•	•	•
Technology Productivity Tools				
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	•	•	•	•

National Educational Technology Standards Performance Indicators for Technology-Literate Students Grades 3-5

STANDARD	SEGMENT			
Technology Communication Tools	**1**	**2**	**3**	**4**
Use technology tools for individual and collaborative writing, communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.	•	•	•	•
Use telecommunication efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.	•	•	•	•
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	•	•	•	•
Technology Research Tools				
Use telecommunication and online resources to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.	•	•	•	•
Use technology resources for problem solving, self-directed learning, and extended learning activities.	•	•	•	•
Technology Problem-Solving and Decision-Making Tools				
Use technology resources for problem solving, self-directed learning, and extended learning activities.	•	•	•	•
Determine when technology is useful and select the appropriate tools and technology resources to address a variety of tasks and problems.	•	•	•	•
Evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources.	•	•	•	•

International Technology Education Association Standards for Technological Literacy Grades 3-5

STANDARD	SEGMENT			
The Nature of Technology	1	2	3	4
Standard 1: Students will develop an understanding of the characteristics and scope of technology.	•	•	•	•
Standard 2: Students will develop an understanding of the core concepts of technology.	•	•	•	•
Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.	•	•	•	•
Technology and Society				
Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.	•	•	•	•
Standard 7: Students will develop an understanding of the influence of technology on history.	•	•	•	•

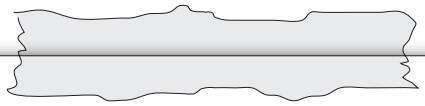
National Geography Standards

STANDARD	SEGMENT			
The geographically informed person knows and understands:	1	2	3	4
The World in Spatial Terms				
How to use maps and other graphic representations, tools, and technologies to acquire process and report information from a spatial perspective		•		
Places and Regions				
The physical and human characteristics of places	•	•	•	•
That people create regions to interpret Earth's complexity	•	•	•	•
How culture and experience influence people's perceptions of places and regions	•	•	•	•
Human Systems				
The characteristics, distribution, and migration of human populations on Earth's surface	•	•	•	•
The characteristics, distributions, and complexity of Earth's cultural mosaics	•	•	•	•
The processes patterns, and functions of human settlement	•	•	•	•
The Uses of Geography				
How to apply geography to interpret the past	•	•		

The NASA SCI Files™

The Case of the Technical Knockout

Segment 1



Animals become the topic of the day when Catherine and Bianca encounter an injured animal while on an airboat ride in Orlando, Florida. Determined to learn more about animals and how to help and protect them, the tree house detectives decide to visit Mr. Rob Yordi, Zoological Manager at Busch Gardens Williamsburg. Mr. Yordi introduces Kali to the grey wolf while he explains how and why animals are classified. Next, Kali meets Dr. D at the Virginia Marine Science Museum in Virginia Beach, Virginia where he explains eight of the various phyla of invertebrates. Meanwhile, Catherine and Bianca head to NASA Kennedy Space Center (KSC) to meet Ms. Rebecca Smith, a wildlife ecologist. Ms. Smith describes five classes of vertebrates and explains why it is important for NASA to monitor the animals at KSC, and she even introduces the girls to one of her reptile friends!

Objectives

Students will

- understand the many uses of the Global Positioning System (GPS).
- learn how coordinate numbers are used to describe the exact position of something, such as a place on a map.
- learn how explorers navigated by using rudimentary technology such as Iceland spar and the stars.

Vocabulary

Arctic Circle—the line of latitude at 66° 30′ N that marks the boundary of the Arctic

cache—a secret place where a store of things is kept hidden

compass—a device for finding direction, usually with a magnetized needle that automatically swings to magnetic north

coordinate—each of a set of numbers that together describe the exact position of something, such as a place on a map with reference to a set of axes

geocaching—an adventure game using GPS devices and the Internet to hide and locate hidden caches of various items all over the world

Global Positioning System (GPS)—a satellite navigation system that gives special satellite signals that can be processed in a GPS receiver to compute position, velocity, and time

navigation—the science of plotting and following a course from one place to another and of determining the position of a moving ship, aircraft, or other vehicle

Polaris—the brightest star in the Little Dipper formation in the constellation Ursa Minor, located very near the celestial North Pole; also called the North Star, Pole Star, and Polar Star

sextant—a navigational instrument incorporating a telescope and an angular scale that is used to find latitude and longitude

sunstone—feldspar or quartz containing minute particles of iron compounds or, in some of the quartz types, mica; also called aventurine and Iceland spar

Viking—a member of any of the Scandinavian peoples who raided and invaded the coasts of Europe from the 8th to 11th centuries AD

Video Component

Implementation Strategy

The NASA SCI Files™ is designed to enhance and enrich existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Before viewing Segment 1 of *The Case of the Technical Knockout*, read the program overview to the students. List and discuss questions and preconceptions that students may have about GPS devices, orienteering, satellites, and how technology changes our world.
2. Record a list of issues and questions that the students want answered in the program. Determine why it is important to define the problem before beginning. From this list, guide students to create a class or team list of three issues and four questions that will help them better understand the problem. To locate the following tools on the NASA SCI Files™ web site, select **Educators** from the menu bar, click on **Tools**, and then select **Instructional Tools**. You will find them listed under the **Problem-Based Learning** tab.

   Problem Board—Printable form to create student or class K-W-L chart

   Guiding Questions for Problem Solving—Questions for students to use while conducting research

   Problem Log and Rubric—Students' printable log with the stages of the problem-solving process

   Brainstorming Map—Graphic representation of key concepts and their relationships

   The Scientific Method and Flowchart—Chart that describes the scientific method process
3. **Focus Questions**—These questions at the beginning of each segment help students focus on a reason for viewing. They can be printed ahead of time from the **Educators** area of the web site in the **Activities/ Worksheet** section under **Worksheets** for the current episode. Students should copy these questions into their science journals prior to viewing the program. Encourage students to take notes while viewing the program to help them answer the questions. An icon will appear when the answer is near.

Video Component

4. **"What's Up?" Questions**—These questions at the end of the segment help students predict what actions the tree house detectives should take next in the investigation process and how the information learned will affect the case. You can print them by selecting **Educators** on the web site in the **Activities/Worksheet** section under **Worksheets** for the current episode.

Careers

pilot
navigator
cartographer
mapping scientist
photogrammetrist
land surveyor
ship's captain

View Segment 1 of the Video

For optimal educational benefit, view *The Case of the Technical Knockout* in 15-minute segments and not in its entirety. If you are watching a taped copy of the program, you may want to stop the video when the Focus Question icon appears to allow students time to answer the question.

After Viewing

1. Have students reflect on the "What's Up?" Questions asked at the end of the segment.
2. Discuss the Focus Questions.
3. Students should work in groups or as a class to discuss and list what they know about orienteering, using a compass, GPS devices, how GPS works, and what it is used for. As a class, reach a consensus about what additional information is needed. Have the students conduct independent research or provide them with the necessary information.
4. Have the students complete **Action Plans**, which can be printed from the **Educators** area or the tree house **Problem Board** area in the **Problem-Solving Tools** section of the web site for the current online investigation. Students should then conduct independent or group research by using books and Internet sites noted in the **Research Rack** section of the **Problem Board** in the **Tree House**. Educators can also search for resources by topic, episode, and media type under the **Educators** main menu option **Resources**.
5. Choose activities from the **Educator Guide** and web site to reinforce concepts discussed in the segment. The variety of activities is designed to enrich and enhance your curriculum. Activities may also be used to help students "solve" the problem along with the tree house detectives.
6. For related activities from previous programs, download the corresponding Educator Guide(s). On the NASA SCI Files ™ home page, click on the fence post for **Guides**. Click on the **Archives** tab and then click on the **2000–2001 Season**. To download the guide, click on Full Guide or the Segment indicated for *The Case of the Challenging Flight*.

   a. In the **Educator Guide** you will find

   a. Segment 2 – *Flight Plan* (cardinal direction)

   b. Segment 4 – *Rescue at Sea Game* (cardinal direction)

   Close the PDF window and return to the page for **Guides**. Click on the **Archives** tab and then click on the **2001–2002 Season**. To download the guide, click on **Full Guide** or the Segment indicated for *The Case of the Phenomenal Weather*.

   a. In the **Educator Guide** you will find

   a. Segment 2 – *Plotting to Rescue* (coordinates)

   b. Segment 3 – *The Fear Factor* (coordinates)

   c. Segment 4 – *NASA Needs Help!* (coordinates)

   Close the PDF window and return to the page for **Guides**. Click on the **Archives** tab and then click on the **2001–2002 Season**. To download the guide, click on **Full Guide** or the Segment indicated for *The Case of the Inhabitable Habitat*.

   a. In the **Educator Guide** you will find

   a. Segment 4 – *Where Have All the Turtles Gone?* (coordinates)
7. Have the students work individually, in pairs, or in small groups on the problem-based learning (PBL) activity on the NASA SCI Files™ web site. To locate the PBL activity, click on **Tree House** and then the **Problem Board**. Choose the **2004–2005 Season** and click on *The Mysterious Technology Glitches.*

- To begin the PBL activity, read the scenario *(Here's the Situation)* to the students.
- Read and discuss the various roles involved in the investigation.
- Print the criteria for the investigation and distribute.
- Have students begin their investigation by using the **Research Rack** and the **Problem-Solving Tools** located on the bottom menu bar for the PBL activity. The **Research Rack** is also located in the **Tree House**.

8. Having students reflect in their journals what they have learned from this segment and from their own experimentation and research is one way to assess student progress. In the beginning, students may have difficulty reflecting. To help them, ask specific questions that are related to the concepts.
9. Have students complete a **Reflection Journal**, which can be found in the **Problem-Solving Tools** section of the online PBL investigation or in the **Instructional Tools** section under **Educators**.
10. The NASA SCI Files™ web site provides educators with general and specific evaluation tools for cooperative learning, scientific investigation, and the problem-solving process.

Resources *(additional resources located on web site)*

Books

Aberg, Rebecca: *Latitude and Longitude (Rookie Read-About Geography)*. Children's Press, 2003, ISBN: 0516277650.

Berger, Melvin: *Simple Science Says: Take One Compass*. Scholastic, 1990, ISBN: 0590423843.

Bredeson, Carmen: *Looking at Maps and Globes (Rookie Read-About Geography)*. Children's Press, 2002, ISBN: 0516259822.

Byers, Ann: *Communication Satellites*. Rosen Publishing Group, 2003, ISBN: 0823938514.

Discovery Channel School: *Mapping the Earth Files: Chart*. Discovery Channel School, 2001, ISBN: 1587381451.

Finch, Spencer: *Map Crosswords: 25 Map/Crossword Puzzles That Teach Map and Geography Skills*. Scholastic, 1996, ISBN: 0590896466.

MacLeod, Elizabeth: *Phone Book: Instant Communication from Smoke Signals to Satellites and Beyond*. Kids Can Press, 1997, ISBN: 1550742205.

Rosinsky, Natalie: *Satellites and the GPS*. Compass Point Books, 2004, ISBN: 0756505976.

Ulmer, Dave: *The Geocaching Handbook (Falcon Guide)*. Falcon, 2004, ISBN: 0762730447.

Whiting, Jim: *John R. Pierce: Pioneer in Satellite Communication*. Mitchell Lane Publishers, 2003, ISBN: 1584152052.

Winter, Jeanette: *Follow the Drinking Gourd*. Dragonfly books, 1992, ISBN: 0679819975.

Zuravicky, Orli: *Map Math: Learning About Latitude and Longitude Using Coordinate Systems (Powermath)*. PowerKids Press, 2005, ISBN: 1404229353.

Video

Discovery Channel School: *Satellite Technology*
Grades 6–12

Web Sites

The Viking Ship Museum
Come explore this site to learn more about the Viking ships on display. Read how these ships were once burial ships for prominent Norwegians from about 815–820 AD.
http://www.khm.uio.no/english/viking_ship_museum/index.shtml

Trimble: GPS Tutorial
Here's a simple tutorial to help you understand a GPS.
http://www.trimble.com/gps/

Howstuffworks: How GPS Receivers Work
Visit this site for an easy-to-understand, in-depth look at how GPS receivers work.
http://electronics.howstuffworks.com/gps.htm

Camp Silos: Farm Tech Trek
This site is a wonderful interactive lesson on how GPS technology helps farmers. Find background information on GPS, satellites, and much more, along with additional resources for both students and teachers.
http://www.campsilos.org/mod4/teachers/farmtrek.shtml

TerraServer USA
On this TerraServer web site, you can see real satellite imagery topographical maps of the United States.
http://terraserver.microsoft.com/default.aspx

US Geological Survey
Visit this web site to learn about topographical maps and become familiar with how to read and understand the symbols used on them.
http://mac.usgs.gov/mac/isb/pubs/booklets/symbols/

Color Landform Atlas of the United States
On this web site you can view topographical maps of the United States.
http://fermi.jhuapl.edu/states/states.html

Space.Com: GPS for Mars
This informative article discusses how NASA might someday create a Global Positioning System for Mars to help explorers navigate.
http://www.space.com/businesstechnology/technology/mars_gps_040707.html

SpaceRef.Com: NASA Satellite Technology Goes Down on the Farm
Read how GPS helps farmers whose tractors are equipped with GPS receivers.
http://www.spaceref.com/news/viewpr.html?pid=4778

NASA: Star Child
Begin your journey here to learn more about stars.
http://starchild.gsfc.nasa.gov/docs/StarChild/universe_level1/stars.html

NASA: Space Place—Make a Star Finder
Learn your way around the night sky by making a star finder. Download a PDF of the Star Finder pattern for each month. Follow simple directions and begin exploring the night sky.
http://spaceplace.nasa.gov/en/kids/st6starfinder/st6starfinder.shtml

Your Sky
Visit this web site and enter your latitude and longitude to create a star chart for your area.
http://www.fourmilab.ch/yoursky/

Stephan F. Austin Observatory
This site offers free PDF Star Charts that include directions on how to use them.
http://www.cox-internet.com/ast305/SFAStarCharts.html

Activities and Worksheets

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Use a compass and learn the four cardinal directions. 19

Boxing the Compass
Discover how young sailors had to learn the 32 points on a compass and try to "box the compass" yourself. 21

Flight of the Navigator
Your GPS is on the blink. Use a compass to help plot a route for the pilot as she flies across the U.S. 23

Dead Reckoning
Set your pace and learn how to use dead reckoning to find distance. 24

Answer Key
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On the Web

Celestial Navigations
Learn about the Big Dipper and find it in your own night sky.

Follow the Drinking Gourd
Learn how slaves used the Big Dipper to find the way north to freedom.

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There's a Rose in My Compass!

Segment 1

Purpose

To understand cardinal direction and how to locate direction by using a compass

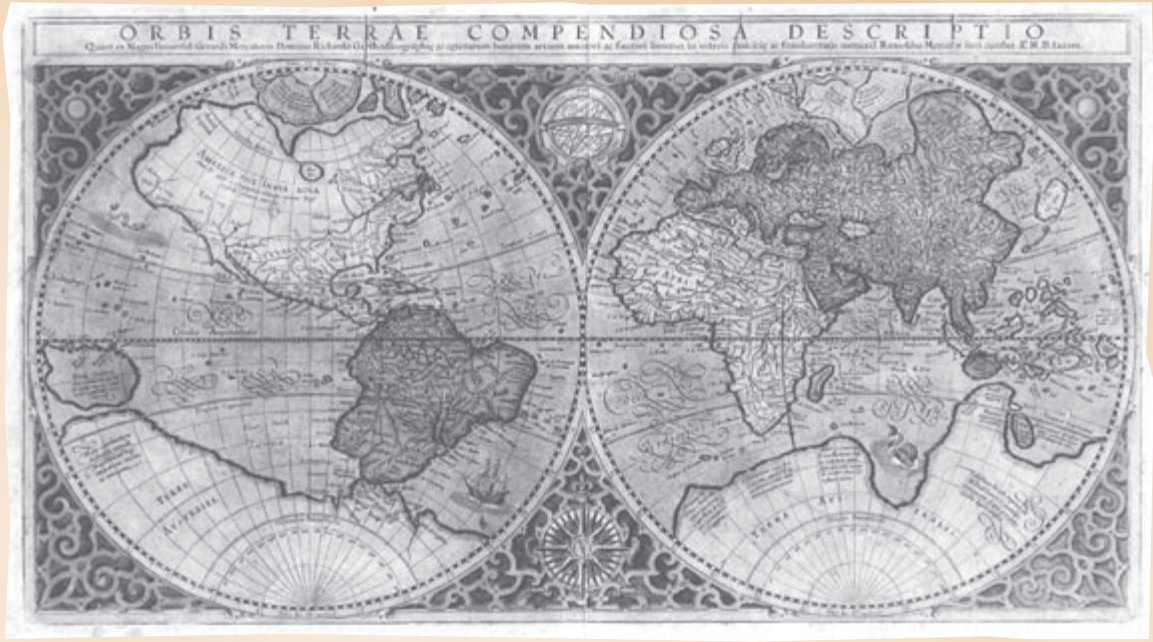
Materials

compass
4 index cards
tape
pen or marker
room with 4 walls
small toy items
plastic bag
science journal

Background

When you look at a map, how can you tell direction? Most maps have a diagram called a compass rose. The compass rose tells you which way is north. If you know a little about direction, once you know where north is, it is pretty easy to find the other directions. There are 4 main (cardinal) directions—North (N), South (S), East (E), and West (W). The first letter of each word is an abbreviation for the direction. A compass shows direction, and the 4 cardinal directions are printed on the compass. Inside the cover of the compass, there is also a tiny pointer needle that can turn freely. One end of the pointer is magnetic and it is usually red. It always points north. All magnets have two poles—a north and a south pole. Opposite poles (N—S) attract, while like poles (N—N and S—S) repel.

Teacher Note: Compass needles can be magnetized in the wrong direction. If this happens, the compass will be reversed. Check the compasses before use to make sure they are oriented correctly.



Procedure

1. On each index card, write one of the 4 cardinal directions: North, South, East, or West.
2. Observe your compass and locate the north-seeking end of the needle. Make sure that the red (or other designated color) end is pointing to the N. If not, tilt the compass and reposition it until it is aligned.
3. Hold the compass in the palm of one hand and observe the direction the needle is pointing.
4. Turn your body so that you are facing the same direction the needle is pointing. You are now facing north.
5. On a spot on the wall in front of you (to the north), tape the "North" index card to the wall.
6. If north is in front of you, then south is directly behind you. Turn around and face south.
7. Look at the compass and observe where the needle is pointing. It's still pointing north!
8. On a spot on the south wall, tape the "South" index card.
9. Face north again. If north is in front of you, then east is to your right.

There's a Rose in My Compass!

Segment 1

10. Turn your body so that you are now facing east. Observe the compass. Is it still facing north?
11. On a spot on the east wall, tape the "East" index card.
12. Face north again. If north is in front of you, west is to your left.
13. Turn your body so that you are now facing west. Observe the compass. Is it still facing north?
14. On a spot on the west wall, tape the "west" index card.
15. Always remember when you are facing north—
    a. north is in front of you.
    b. south is behind you.
    c. east is to your right.
    d. west is to your left.
16. To make a compass rose, draw a circle in your science journal. Draw a line to divide the circle in half from top to bottom. Label the line at the top N and the bottom line S.
17. Draw a second line to divide the circle in half from side to side, making four equal quarters. Label the line on the right E and the left W.
18. Look at the four directions and try to memorize them in a clockwise direction. A saying that might help is "Never (N), Eat (E), Sour (S), Watermelon (W)."
19. Now that you have identified the 4 cardinal directions in the room, you are ready to create a cache, hide it, and write directions to find it.
    a. To create a cache, choose 1–2 small toy items and place them in a small plastic bag.
    b. Find a location to hide your cache.
    c. In your science journal, write a set of directions using N, S, E, and/or W to guide someone to your cache. For example: Begin at the door and take 4 steps N. Turn to the W and take 2 steps. Turn to the E and take 4 steps. Turn to the S and take 1 step, and so on.
20. Exchange directions with another student and try to find each other's caches.

Conclusion

1. Explain why the compass needle always points north.
2. Give an example of how you would use a compass to find your way while hiking.
3. Help the tree house detectives and brainstorm for some ideas of what might make a compass give a wrong direction. Remember that the needle is a magnet.

Extensions

1. Go outside or to a large, enclosed area and practice using a compass.
2. Write a set of directions to maneuver around a set of obstacles.
3. Use a compass to determine in which direction the Sun rises and sets. The Moon?
4. Take a short walk around the house or classroom with your compass. Hold the compass next to different items such as a sink, table, door, TV, refrigerator, or other object. What happens to the compass needle with each item?
5. Research the difference between the magnetic pole located in the north and the geographical north pole. How far apart are they from each other? Explain why they are different.

EG-2005-05-04-LARC

Boxing the Compass

Segment 1

Purpose

To learn the order of cardinal and intercardinal points on a compass

Materials

Per Student
sheet of unlined paper
ruler
pencil
small compass

Background

A compass rose is a symbol drawn on a map to show direction. It has appeared on charts and maps since the 1300s and was first used to show wind direction. A compass rose gets its name from a flower because the figure is said to resemble the petals of a rose. The Portuguese cartographer (mapmaker), Pedro Reinel, drew the first standard compass rose. The standard compass rose has 32 points. Long ago, if you were a young sailor between the ages of 8 and 12, the first thing you would do is memorize all 32 points in order. Being able to recite all 32 points in their correct order was called, "to box a compass." Today a compass rose shows the four cardinal points of north (N), south (S), east (E), and west (W) and some still have the intercardinal points between the four cardinal points.

To learn more about a compass rose, visit the following web sites:

http://www.gisnet.com/notebook/comprose.html#32points

http://www.rootsweb.com/~mosmd/comrosbig.htm

Procedure

1. Fold the paper in half (bottom to top). See diagram 1.
2. Open up the paper and fold it from side to side. See diagram 2.
3. Open the paper and place it flat on the table or desk.
4. Use a ruler to draw lines along the fold lines. See diagram 3 on page 22.
5. Place a small compass where the two lines intersect.
6. Turn your compass so that north is pointing to the top of the page. All four lines should be aligned with the cardinal points. See diagram 4 on page 22.
7. Label the end of each line with a direction: N for north, S for south, E for east, and W for west.
8. Use the ruler to draw a line between south and west from the center to the lower left-hand corner.
9. It points southwest. Label it SW. See diagram 5 on page 22.
10. Use the ruler to draw a line between north and west from the center to the upper left-hand corner.
11. It points northwest. Label it NW.
12. Use the ruler to draw a line between north and east from the center to the upper right-hand corner.

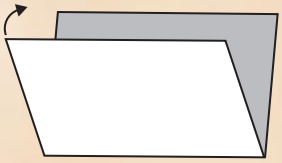


Diagram 1

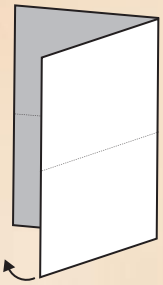


Diagram 2

Boxing the Compass

Segment 1

13. It points northeast. Label it NE.
14. Use the ruler to draw a line between south and east from the center to the lower right-hand corner.
15. It points southeast. Label it SE.
16. The drawn lines indicate the 8 main points on a modern day compass. Try to "box the compass" by memorizing all 8 points in order, starting with north.

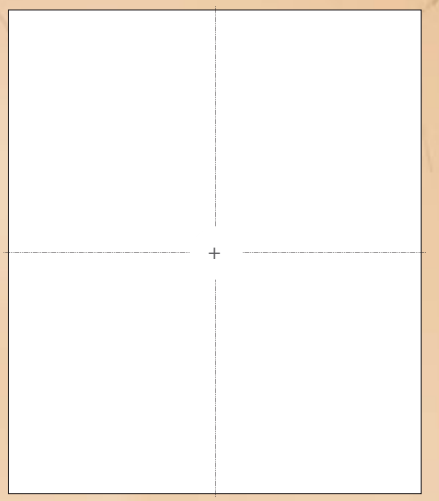


Diagram 3

Conclusion

1. Why was it important for young sailors to "box the compass?"
2. How does learning to "box the compass" help you?

Extension

1. Research the origin of the compass rose and explain how and why it was created.
2. Draw and label all 32 points on a compass rose. Explain how and why sailors used the 32 points.

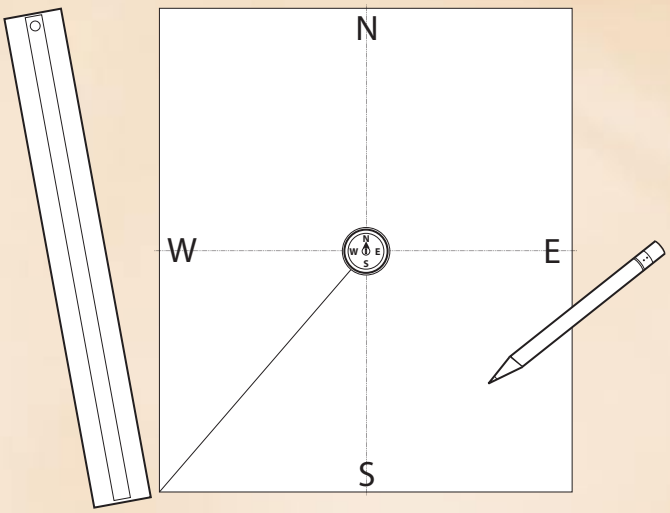


Diagram 5

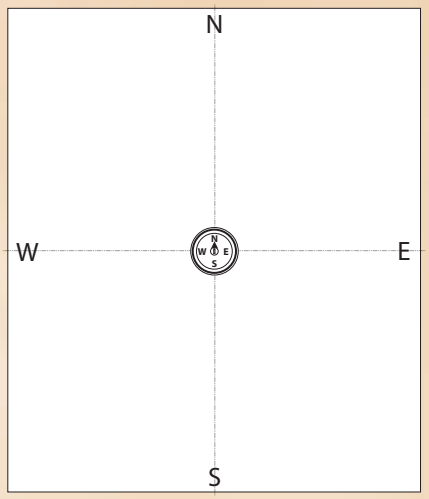


Diagram 4

EG-2005-05-04-LARC

Flight of the Navigator

Segment 1

Purpose

To demonstrate knowledge of direction

Your GPS is on the blink! Luckily you have a compass. As flight navigator, it is up to you to map a route so the pilot can safely fly from city to city. Use your compass to plot the course to the following cities, being sure to direct the pilot to each city in the order it is listed. Write the directions for the route in your science journal. When you are finished, exchange directions with a partner and try to "fly" to the cities by using your partner's directions. Discuss any difficulties you might encounter!

Materials

US map
compass
science journal

Extension

Research how pilots actually fly in great circles. Describe a great circle and explain how the actual flight path would differ from one drawn on a flat map as a straight line.

San Francisco
Las Vegas
Everett, Washington
Denver, Colorado
Kansas City, Missouri
Fargo, North Dakota
Memphis, Tennessee
Oklahoma City, Oklahoma
College Station, Texas
Atlanta, Georgia
Cleveland, Ohio
Yorktown, Virginia
New York, New York

Dead Reckoning

Segment 1

Purpose

To learn how math helped explorers navigate

Materials

yardstick*
duct tape
large area > 100 ft
calculator (optional)

Background

Long before people had GPS receivers, they navigated with nothing but a compass, a clock, and math. Explorers frequently relied on dead reckoning. Dead reckoning is an estimated linear measurement. To use dead reckoning, people first had to calculate their average pace, or how many steps they took in a given space. They could then divide the distance they walked by the average number of paces to calculate the average number of feet per step. If they wanted to measure a distance by dead reckoning, all they would have to do is count the number of steps they took and multiply that number by their average pace. Although the method is crude, people who practice pacing can get fairly accurate measurements over long distances. Early ships frequently relied on dead reckoning, but it was often inaccurate because a ship's travel speed is inconstant, and ocean currents can cause the ship to drift off course. Even on land dead reckoning is difficult because of rocks, trees, and other obstacles that cause detours. Even so, throughout history most great explorers relied on dead reckoning. Today it is a dying art. However, if your GPS goes on the blink as the tree house detectives' did, or if the batteries die, dead reckoning can be a good navigational tool to have.

***Note:** This activity is in standard units of measurement but can be converted to metric.

Procedure

1. Place a piece of duct tape at one end of the large area.
2. Use the yardstick to measure 100 ft from the duct tape and mark the end with a second piece of duct tape.
3. Start at one of the markers with your feet together and walk directly to the other marker, counting each step you take. Make sure to walk with a normal gait.
4. Stop when you get to the second marker and record in the chart the number of paces you took.
5. Turn around and walk back to the first marker.
6. Record the number of paces.
7. Repeat steps 3–6 two more times.
8. Calculate the average number of paces you took for 100 ft.
9. Divide 100 by your average number of paces to find your pace in terms of feet per step.
10. Choose a different spot and walk to it, counting your paces as you go.
11. Record the number of paces in the chart.
12. To measure the distance by dead reckoning, multiply the number of paces by your average feet per step.
13. Use the yardstick to measure the actual distance. Record and compare the two numbers.

Dead Reckoning

Segment 1

Trial	Number of Paces per 100 ft
1	
2	
3	
4	
5	
6	
Total Number of Paces per 100 ft	

_____ ÷ 6 = _____
Total Number of Paces **Average Number of Paces per 100 ft**

_____ _____ = _____
Number of paces to new location Average feet/step Dead Reckoning Distance

Actual Distance: _____

Conclusion

1. How did your numbers compare?
2. How could you improve your margin of error?
3. What might be some factors that cause error in your ability to correctly use dead reckoning?
4. When would dead reckoning be useful?

Extension

Conduct research to learn how ancient ships' crews used dead reckoning. Discuss the differences and similarities between dead reckoning on a ship and by pacing on land. Share your research with the class.

Answer Key

Segment 1

There's a Rose in My Compass!

1. The compass needle and the Earth are both magnets. Magnetic poles are determined by the direction that the magnetic field flows. A magnetic field always flows from the north pole to the south pole. See diagram 1. Our Earth has gone through many field (pole) reversals throughout time. Currently, the magnetic north pole is located in the geographic south pole region and the magnetic south pole is located in the geographic north pole region. See diagram 2. The end of the compass needle that points north is actually a north pole and because opposites attract, it is attracted to the Earth's magnetic South Pole, which is in the North. The Earth's magnetic field is constant; therefore, the compass needle will always point north until the poles reverse again.
2. Answers will vary, but might include to track the direction you hike so that you can find your way back.
3. Answers will vary, but should include that because the compass needle is a magnet, it is sensitive to iron and thus will be attracted to items with iron in them. If an iron item were nearby, it would create a stronger attraction than the Earth's magnetic field and cause the compass to give a wrong direction.

Boxing the Compass

1. Answers will vary but might include that young sailors were expected to know direction as part of their seamanship training because it was very important for them to know about wind direction. The 32 points originally represented wind direction and that information could be very useful because ships depended on wind to fill their sails! The 32 points also let them define their direction more precisely.
2. Answers will vary, but might include helping you find your way, giving other people directions, and helping you read maps.

Dead Reckoning

1. Answers will vary.
2. Answers will vary but might include conducting more trials or practicing pacing more evenly.
3. Answers will vary, but might include that the pace was off due to being tired or having a sore foot, or that someone did not count the paces correctly.
4. Answers will vary, but might include the following: when you are hiking in the woods, sometimes you know that you need to go a certain distance in a specific direction to reach a destination.